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Regulatory Proposal PRO2014-02

Updated Agricultural Transfer Coefficients for Assessing Occupational Postapplication Exposure to Pesticides

(publié aussi en français)

16 September 2014

This document is published by the Health Canada Pest Management Regulatory Agency. For further information, please contact:

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ISSN: 1197-740X (print)
1925-122X (online)

Catalogue number: H113-8/2014-2E (print)
H113-8/2014-2E-PDF (PDF version)

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1.0 Summary

Transfer coefficients (TCs) are used by Health Canada's Pest Management Regulatory Agency (PMRA) when calculating postapplication exposure to agricultural workers for human health risk assessments. The United States Environmental Protection Agency (USEPA) recently developed a database of TCs based on data presented by the Agricultural Re-entry Task Force (ARTF) to the United States' Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel in 2008. The PMRA has similarly updated the Canadian agricultural TCs based on the ARTF data. The updated agricultural TC table is available from the PMRA upon request.

These values may be updated on an on-going basis, as additional information is submitted to the PMRA.

2.0 Purpose

The purpose of this document is to provide an update to stakeholders on the TCs used by the PMRA when calculating postapplication exposure to agricultural workers.

The PMRA is also soliciting comments on the following specific questions on the agricultural TC table:

- Does handline irrigation (in other words, movement of irrigation pipes) occur with the crops identified?
- Are there any crops or activities missing? If so, please describe the crops and activities, including the typical crop height and foliage density at the time these activities occur.

The PMRA will accept written comments from the public on the PMRA agricultural TCs up to 45 days after publication of this document. Send your written comments by e-mail, fax or regular mail to Publications (see contact information on the cover page of this document).

3.0 Data Access

The TCs discussed in this document are based on proprietary data submitted to the PMRA by the ARTF, which is a joint data development task force made up of pesticide registrants.

For new active ingredients or use expansions, ARTF data can only be used for products for which the registrant is a member of the ARTF or has access to the data. 'Registrant' refers to the registrant of the end-use product and/or the registrant of the technical grade active ingredient from which the end-use product is formulated. If neither the technical registrant nor the end-use product registrant are members of this Task Force, then non-proprietary TCs will be used in the agricultural postapplication exposure assessment (USEPA, 1998), although there are limitations with this data, as discussed below in Section 4.0. Alternatively, registrants can submit equivalent data to develop their own TC.

For re-evaluations of older active ingredients, ARTF data can be used for all products. If a registrant of the technical grade active ingredient from which the registered end-use products are formulated is not a member of the Task Force or does not have access to the data, then the ARTF data would be considered 'compensable'.

For more information on PMRA's data protection policies, refer to:

- Discussion Document DIS2012-01, *Reliance on Proprietary Data for the Purpose of Re-evaluation and Special Review*,
- Regulatory Directive DIR2010-04, *Guidelines for Reliance on Proprietary Data Under the Pest Control Products Regulations*,
- Regulatory Directive DIR2008-01, *Registering a New Source of Technical Grade Active Ingredient Under the Protection of Proprietary Interests in Pesticide Data Policy*, and
- Regulatory Directive DIR2007-03, *Protection of Proprietary Interests in Pesticide Data in Canada*.

4.0 Background

Under the *Pest Control Products Act*, the PMRA has the responsibility to protect the health of Canadians from unacceptable risks associated with pesticide use. In order to assess potential risks of pesticide use to the health of Canadians, the Agency must be able to estimate their potential exposure to pesticides and any pesticide transformation products that might be of toxicological concern. Occupational exposure assessments must be comprehensive and include potential pesticide exposure by all routes (dermal, inhalation). Estimating potential exposure to workers entering an area that was treated with pesticides is an important part of occupational exposure assessments.

Agricultural postapplication exposure assessments estimate potential exposure to pesticide residues when workers enter a treated area to perform certain activities. Residues that are on plant foliage and are available for transfer are called dislodgeable foliar residues (DFR). Residues that are on the surface of turf and are available for transfer are called turf transferrable residues (TTR).

A TC is an empirical measure of residue transferability from the foliage of plants or turf onto a worker's skin or clothing through contact. They are determined from worker exposure studies (typically passive dosimetry studies), and concurrent DFR or TTR studies. Conceptually, a TC may be thought of as a 'contact factor' determining a worker's exposure to DFR or TTR depending on what activity they are doing, the length of the workday, and how much residue is available for contact and transfer. Mathematically, this is expressed as follows.

Transfer Coefficient Derivation Equation:

$$\text{TC for a given crop/activity } (\text{cm}^2/\text{hr}) = \frac{\text{Dermal Exposure (mg/day)}}{\text{Time performing activity (hr/day)} \times \text{DFR/TTR } (\text{mg/cm}^2)}$$

Transfer coefficients can be determined for any given crop or, potentially, crop stage and activity combination (for example, hand harvesting apples, scouting late season corn) from postapplication worker exposure monitoring studies and concurrent DFR or TTR sampling. These crop and activity combinations are referred to as clusters.

The early work performed in establishing TCs demonstrated that postapplication exposure was primarily a function of the degree of body immersion in treated foliage and that it could be used as a generic tool for estimating exposures to workers based on a chemical-specific DFR dissipation curve. Regulatory experience in the use of TCs has demonstrated this to be valid for conventional pesticides whose physical and chemical properties fall within a similar range, and where dislodgeable foliar residues are neither very low nor very high. For most conventional pesticides, TCs can be used generically between different active ingredients; however, DFR and TTR data are chemical-specific. This process is considered a reasonable method for assessing exposure while saving the time and resources associated with conducting passive dosimetry or biological monitoring exposure studies for all proposed pesticide registrations and registration reviews, including the multitude of scenarios and uses therein.

TCs are used by PMRA and other regulatory agencies to estimate postapplication exposure. Historically, PMRA used a non-proprietary database of TCs (USEPA, 1998) for agricultural risk assessments. However, there are limitations with this database as the values were not quantitatively derived based on data, rather they were determined by pesticide exposure assessors based on professional judgement.

In October 1995, the USEPA issued a data call-in notice to all pesticide registrants requiring data on dislodgeable foliar residues and dermal TCs for virtually all pesticides applied to agricultural crops. In anticipation of the data call-in, the ARTF was formed by a number of pesticide registrants.

The approach taken by ARTF to address these data requirements, developed in consultation with the regulatory agencies, was based on the monitoring of selected activities that are used to represent similar types of activities as defined by the crop, the ergonomics of the postapplication activity, and the potential for contact with pesticide residues. For example, it is believed that harvesting oranges and apples have similar exposure potential because both crops are grown similarly in orchards making the physical act of harvesting and potential for contact with foliar residues essentially the same. Due to these similarities it would then be expected that the TC for each activity would be similar since it is a measure of the potential contact with pesticide residues.

During the data development, a major undertaking of the regulatory agencies and the ARTF was to identify all activities which occur in agriculture that are necessary for the production of a crop. Aspects of this process involved distinguishing between those hand labour activities that have routine, substantive exposures associated with them and those activities which have a negligible exposure potential. Grower and expert surveys conducted by ARTF in the United States and Canada, consultation with those involved in agriculture, as well as information from crop profiles and agronomic texts were used to identify specific activities that occur in agriculture. The conclusions drawn based on this information were correlated with other independent

sources, such as the National Agricultural Workers Survey by the United States Department of Labor. Based on the above information, a list of all possible agricultural activities totalling approximately 4500 crop-activity combinations was produced. These were then grouped into clusters of naturally similar crop-activity types.

The ARTF developed a database of modern worker exposure studies and concurrent DFR or TTR studies to calculate TCs, which are conducted according to current guidelines and are reflective of current agricultural practices. These studies were reviewed for use in regulatory agricultural risk assessments by the PMRA in cooperation with the USEPA and the California Department of Pesticide Regulation. All three agencies supported the use of the ARTF studies as the basis for revised agricultural TC values.

These data and a general approach to TCs were presented to the United States' FIFRA Scientific Advisory Panel in December 2008 (USEPA, 2008, 2009). The presented approach was generally accepted by the USEPA, California Department of Pesticide Regulation and Health Canada's PMRA. Based on the FIFRA Scientific Advisory Panel review and subsequent discussions, the USEPA developed a database of agricultural TCs. The TCs discussed in this document are similar to those recently published by the USEPA (2012) and reflect the ARTF TCs used by Health Canada for the regulation of pesticides.

5.0 PMRA Agricultural Transfer Coefficients

A summary of the PMRA TC clusters applied in the PMRA agricultural TC table is provided in Table 1. Most of the clusters are similar to those presented by the ARTF to the FIFRA Scientific Advisory Panel (USEPA, 2008); however, some were modified by the Agencies. Those clusters that are different than those proposed by the ARTF and were developed by the USEPA and adopted by PMRA are identified with an "(EPA)" notation, while those clusters that are unique to PMRA are identified with a "(PMRA)." Unique clusters were developed when there were differences in acceptance of individual studies and clustering rationales between PMRA, EPA and/or what was proposed by the ARTF.

The PMRA's agricultural TC table is available upon request.

Table 1 ARTF Studies Used To Develop PMRA TC Clusters[a]

ARTF Study		TC Cluster		
		Code[b]	TC (cm^2/hr)	Description
Hairy-Leaf Field Crops				
ARF045	Cucumber Hand Harvesting	HH	550	Hairy-leaf field crops: hand harvesting and similar contact activities
ARF049	Summer Squash Hand Harvesting			
ARF024	Tobacco Hand Harvesting	HHt	800	Hairy-leaf (Tobacco): Hand harvesting and canopy management
ARF022	Sunflower Scouting	HS	90	Hairy-leaf field crops: scouting and similar contact activities

ARTF Study		TC Cluster		
		Code[b]	TC (cm^2/hr)	Description
Smooth-Leaf Field Crops				
ARF051	Tomato Tying	SH	1100	Smooth-leaf field crops: hand harvesting and similar contact activities
AR1001	Strawberry Hand Harvesting			
AR1025	Cotton Scouting	SSr	210	Smooth-leaf field crops: scouting in row conditions
AR1027	Tomato Scouting			
ARF009	Corn Scouting	SSs	1100	Smooth-leaf field crops: scouting in solid stand conditions
ARF021	Dry Pea Scouting			
AR1006	Cotton Hand Weeding	Sw	70	Smooth-leaf field crops: hand weeding, thinning, and similar contact activities
AR1018	Cotton Hand Weeding			
AR1019	Dry Pea Hand Weeding			
ARF010	Sweet Corn Hand Harvesting	Sx (EPA)	8800	Smooth-leaf field crops: intense contact activities
AR1003	Sweet Corn Hand Harvesting			
Waxy-Leaf Field Crops				
ARF011	Cauliflower Scouting	WMS (PMRA)	4000	Waxy-leaf field crops: scouting and similar contact activities in medium height conditions
ARF012	Cauliflower Hand Harvesting	WMH (PMRA)	5150	Waxy-leaf field crops: hand harvesting similar contact activities in medium height conditions
ARF037	Cabbage Hand Weeding	WW (PMRA)	4400	Waxy-leaf field crops: weeding and similar contact activities
ARF050	Cabbage Hand Harvesting	WL (PMRA)	1300	Waxy-leaf field crops: hand harvesting and other activities in low crop height conditions
Orchard Crops				
ARF025	Apple Hand Harvesting	OH (EPA)	1400	Orchard crops: hand harvesting and similar contact activities
ARF028	Orange Hand Harvesting			
ARF041	Orange Hand Harvesting			
ARF042	Grapefruit Hand Harvesting			
AR1002	Peach Hand Harvesting			
AR1014	Peach Hand Harvesting			
AR1003	Apple Thinning	OT (EPA)	3000	Orchard crops: thinning

ARTF Study		TC Cluster		
		Code[b]	TC (cm^2/hr)	Description
AR1016	Almond Mechanical Harvesting	OHn	190	Orchard crops: mechanically harvesting nuts
ARF033	Olive Hand Pruning	OP	580	Orchard crops: hand pruning, scouting, and similar contact activities
ARF047	Apple Hand Pruning			
AR1017	Peach Propping	OW	100	Orchard crops: hand weeding and similar contact activities
Crops With Handline Irrigation				
ARF036	Potato Irrigation	I	1750	Irrigation, any crop where hand line is possible
Trellis Crops				
ARF020	Blackberry Hand Harvesting	THb	1400	Trellis crops: hand harvesting and similar contact activities in caneberries and bushberries
ARF048	Juice/Wine Grape Hand Harvesting	THg (PMRA)	8500	Trellis crops: Hand harvesting and similar contact activities in grapes and kiwi
AR1020	Table/Raisin Grape Hand Harvesting			
ARF023	Table/Raisin Grape Scouting	TP	640	Trellis crops: hand weeding, scouting, and similar contact activities in grapes, caneberries and bushberries
AR1015	Table/Raisin Grape Cane Turning	Tx	19300	Trellis crops: intense contact activities in table grapes and hops
Greenhouse and Field Ornamental Crops & Greenhouse Vegetable Crops				
ARF055	Solidasters, Snapdragons, Lilies Hand Harvesting	Gcf (PMRA)	4000	Greenhouse and field ornamental cut flowers: hand harvesting and similar contact activities
Brouwer *et al.* 1992	Carnation Hand Harvesting			
Schneider *et al.* 2002	Carnation and Rose Hand Harvesting			
ARF039	Chrysanthemum Pinching	GN	230	Greenhouse, field, nursery and ornamental crops: all activities for potted plants Greenhouse lettuce: All activities All crops: transplanting
ARF043	Citrus Tree Hand Pruning			
ARF044	Citrus Tree Hand Harvesting			
ARF020	Blackberry Hand Harvesting	GHveg (PMRA)	1400	Greenhouse vegetables (tomatoes, peppers, cucumbers): all activities
ARF051	Tomato, Fresh Tying			
Schipper *et al.* 1998	Greenhouse Cucumber Harvesting/Tying			

ARTF Study		TC Cluster		
		Code[b]	TC (cm^2/hr)	Description
Turf				
ARF035	Sod Mechanical Harvesting	DH	6700	Mechanically harvesting and transplanting turf for golf courses and sod farms
ARF057	Golf Course Turf Maintenance	DM	3500	Mowing, watering, irrigation, as well as golf course maintenance activities in golf courses and sod farms
	Golf Course Turf Maintenance-greens, teas and approaches only	DMg (EPA)	2500	Maintenance activities in greens, teas and approaches only
ARF057	Golf Course Turf Maintenance	DS (PMRA)	1000	Fertilizing, hand pruning, scouting and similar contact activities in sod farms and golf courses

[a] Values may be updated on an on-going basis as additional information is submitted to the PMRA.

[b] Each clustering of crops and activities described in the 'Description column' is assigned a code. That cluster code is essentially the name of the cluster. (EPA) = cluster developed by USEPA and adopted by PMRA; (PMRA) = cluster developed by PMRA. All other clusters were proposed by the ARTF and accepted by EPA and PMRA.

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